



Panel 1 of 4

Estimating Multiphase Hydraulic Properties at a Crude-Oil Spill Site

William Herkelrath, Hedef Essaid, and Leslie Dillard

U.S. Geological Survey, Water Resources Division, Menlo Park, California

OBJECTIVE

Our goal was to estimate multiphase hydraulic properties needed in research investigations of flow, transport, dissolution, and degradation processes occurring at the field scale within an aquifer contaminated by oil. As an example application, the estimated hydraulic properties were used in simulating the oil saturation distribution within and above the aquifer.

BACKGROUND

We studied a site near Bemidji, Minnesota, where crude oil from a 1979 pipeline break infiltrated the soil and spread laterally at the water table, creating a lens of oil-contaminated aquifer approximately 100 meters long. Laboratory measurement of the three-phase capillary pressure and relative permeability relations using field aquifer and oil samples is extremely challenging. Because large numbers of samples have to be run, adequately characterizing a heterogeneous field environment using laboratory measurements is very expensive and time consuming. As an alternative, we adapted and developed methods of estimating multiphase hydraulic properties from more easily measured parameters such as the sediment particle-size distribution and porosity.

FIELD OBSERVATIONS

Detailed three-dimensional distributions of oil, air, and water content, particle size analysis, and porosity were determined using analyses on more than 500 core sections obtained from within the aquifer and in the unsaturated zone above the oil pool. A side view of the observed oil saturation distribution is shown below.

Subsurface oil saturation distribution

